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QUALITY AND QUANTITY.[1]

THE problem of quality and quantity implies two distinct studies, which we shall combine here for greater convenience in exposition. The first is of an historical nature and must answer the question: What is, in the history of philosophy, the exact meaning of the opposition of the concepts of quality and quantity? or, in other words, what is the original attitude of modern physics toward the old conception? The second study, of a purely rational character, must solve the question, What is the psychological meaning of the words quality and quantity, and from a scientific point of view what is the import of the contrast of two categories so long admitted to be mutually irreducible? in other words, what must be thought of the transition from the unextended to the extended? or, in any case how is it brought about, and what is really the value of the distinction between intensive and extensive magnitude—the latter being clear and serving as an adequate symbol to the former which is as confused as the very depths of being?

I.

Quality and quantity characterize very exactly the two points of view, from which the human mind has successively regarded physics during the long history of the progress of that science taken in its most general sense. In turn each term becomes the crucial test as to the nature of matter: quality is the pivot around which the old science of physics gravitates; quantity, the new. Between these two conceptions has evolved the theory of living beings as well as that of inorganic bodies. It is enough to say that the problem of the relation of quantity to quality is not lacking in interest. We will consider here only very general ideas.

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[1] Translated by Amélie Séraphon.

These then are the terms of the psychological problem:

1. From the subjective point of view, trying to find quantity in quality will be looking for the application of the law of number or measure in the realm of mere intensity; it will be reducing to well-known proportions the mobile and intangible depths of sensation; it will be finding out the connection between the object exciting sensation, and the sensation itself. From this point of view, however, one particular will always escape us, and that is the purely emotional and affective in sensation.

2. From the objective point of view, searching for quantity in quality, will be passing from the subject to the object, by reducing to distinct and clear formulas the sensations that we interpret as signs of some object outside of ourselves; it will be affirming that we know objects only in relation to the clear ideas we have of them, and that the reality of the external world is connected with the evidence of the mathematical formulas to which we reduce them. This is again transferring the unextended into the extended, and making general mathematics the condition of all certitude. But from this point of view also, one thing will always escape us, namely: to know the very fundamental facts set in equation, and the necessity of this interdependence postulated *a priori* of reason and reality. Therein lies the great problem of thought.

Sound, color, odor, taste, cold and heat, resistance, weight, hardness, shape, situation, and movement: in these consists all our external world, or at least as much of it as can be perceived by a consciousness in which reflection has had no part. The distinction between the qualitative and the quantitative point of view that we establish in things, is not so clear on the whole as it would seem at first. Common sense, far from seeing a great difference between the extensive and intensive, makes of them two forms of one and the same thing, as it were. It immediately looks upon quantity and quality as notions fusing into the unity of an object of which they express different modes of existence on a common basis. Thus quality and quantity imply each other, since all ideas relating to magnitude indicate as many ways of existing, and everything that serves to determine the nature of a thing is rightly called quality. Such is the common opinion. We shall see later, on what preconceived idea it rests. Now we shall limit ourselves to stating that this radical difference which is primarily established between quality and quantity is not founded on reason. What we first know are the sensations which we distinguish from what we suppose to be their causes; that is to say, we first perceive ourselves and afterwards that which is not ourselves.

II.

Before going further, let us examine what may fitly be called the distinction between primary and secondary qualities. Does such a distinction impress itself upon the popular mind? or is it but the sublimated result of reflecting thought?

It seems to me that common sense clearly makes this distinction. As we have said it intreprets all sensations, in so far as they relate to an external object, as qualities of that object and places them nearly on the same level. Moreover, the contradiction of primary and secondary qualities is no longer of any consequence whatever, since science has shown most emphatically that both were in the first place, but states of consciousness identical by nature; and in the second place, that they were only the different expressions of the action upon us of a certain cause under given conditions, and following a ratio of which one's own self is one of the terms, and the cause in question which remains to be determined, the other.

People say, "We know the primary qualities quite clearly; the secondary but confusedly." This argument in favor of a distinction had its value when science had not yet shown what could be expected of it. But now we know how to regard all those sensations formerly thought to be confused from the fact that they could not be measured, and qualities such as sound, color, odor, taste; or such others as weight, resistance, impenetrability, and in general all sensations which with the exception of extent, shape, and size were considered secondary (that is to say, confused) are at present quite susceptible of being submitted to measurement and therefore to quantity. This progress in analysis makes sufficiently clear how slight is the foundation for a distinction uncritically established, and also how necessary it is to continually verify the content of certain notions, the frequent use of which blinds us to their significance.

III.

But how to escape from sensation? How can we pass from quality to quantity? Here indeed arises the psychological problem which interests us.

At this moment I experience a sensation of heat. What is the meaning of this fact? It means that just now my consciousness subsumes its present state under a class of past conditions called heat. Strictly speaking, I have not a sensation of heat in me. My being is simply in a certain state different from the preceding and it has the consciousness of this state and of this difference. I try to find the reason of this sensation. Now as I am near the fire I conclude that the fire is the cause of my actual condition; and then passing from my self to what is not myself, I affirm that the fire has a property, a quality, that of causing warmth.

It is important to establish the terms of the ratio: on one side, my own self; on the other, that which is certainly not my self. Two terms being present I have the right to establish the relation, and it is expressed here for me by the sensation of warmth. Have I perceived by this sensation a quality of the fire? I cannot state positively that I have; for a relation is never an expression of the existence of one of the two terms on which it rests. It is only the new result derived from a comparison of the two terms, but is neither the one, nor the other. In the above instance my sensation of warmth is but the *tertium quid,* resulting from the fact that my body is near another body which I call "fire." That is all I can say about it.

Let us continue the analysis. According to the judgment of common sense, actual sensation is what puts me into direct and immediate communication with the external world. Practically this belief in the comprehension of external reality is sufficient. I say that I am actually warm and that this sensation is not the result of my own will. Now by repeated experiments I have come to know that fire has the property of causing the feeling which I now experience. Hence I conclude that fire has one quality (among others, doubtless) that experience has already revealed to me or will in the future, namely, that of warming; and that is enough for every-day use.

But the reasoning of the scholar is quite different. He will not draw his conclusion simply from self and non-self. He will not say: "I am warm now because the fire is warm" or "because there is heat in the fire." How could he really know it since he perceives but the actual sensation which can only give him what it implies, namely a state of consciousness for himself who experiences it, and not a certain quality of the fire, the existence of which he could only affirm positively by transporting himself momentarily into the consciousness of the fire, supposing it to have one. So the philosopher instead of concluding from a psychological state a reality outside of himself—an entity which would explain nothing—would try instead to lift the veil from the illusion of common sense. Applying the process of analysis to the actually experienced sensation, he will there establish a very nice distinction. He will first of all try to find out what this sensation within himself may be, and will say, "It is only a state of my own self; it is still my own self, but different from what it was an instant before." But here he is only at the philosophical explanation of the popular point of view; and if he did not go further with his reasoning, this consciousness of a certain psychological state which has been preceded by another, and will be followed by an infinite number of others, in other words, the consciousness of a possible series of psychical states, would be practically sufficient for him.

But this knowledge pertains only to his own being, and does not inform him of what is commonly called the external world. He is led to ask himself what it is he really knows of this state of consciousness. I say that it is a state of my being; but if I cannot reduce it to anything simpler, in what way will this knowledge help me on with the idea I have of it? And I shall never be able to escape from the narrow circle in which the actuality of this condition encloses me, unless we suppose that spontaneously and without our being able to explain this psychological mystery, thought lays down the postulate of otherness, that is to say, something different from my present state.

Note that there is nothing excessive in the claim of this postulate. In fact we treat here the question of the psychological origin of belief in an external reality, which is found closely combined with our affirmation of the existence of qualities outside of ourselves. Now to make this task easier, we have the right to take into account all that philosophical reflection has created in the external world whether under the name of illusion or of reality. In short, we cannot neglect all the facts which actually constitute for us that kind of moral certainty which Descartes mentions. We have recourse to that well-known process of demonstration which consists in taking for granted what we are about to demonstrate. In a word, to give a solid foundation to our thesis on quality and quantity we take our footing on the notions which we consider provisionally in the light of purely moral or practical certainties and of which we shall bring out the rational character afterwards.

So, admitting the postulate of an existence foreign to mine, and which I suppose to be the cause of certain sensations for me, am I entitled to say that these sensations are qualities of an object? No, I simply affirm a relation and still have to deal only with the question of states of consciousness. In order to have a clear idea about quality and quantity, our thought must have become conscious of the objective laws which govern it. "Mere consciousness of my own existence, if empirically determined," says Kant, "proves the existence of external objects." It is necessary to understand well the sense of this theorem. I do not conceive external objects independently from my thought, but only inasmuch as they are matter necessary to its activity. My thought cannot become isolated from its external condition. In order to regard itself as a series of states of consciousness, it must take hold of something upon which to record these states. Thus we manage to affirm the existence of an external object which up to the present time was entirely unknown, and to which we attribute as its own by a sort of illusion, qualities that are in reality nothing but our own sensations. Herewith ends the first stage of psychical processes that lead the philosopher to establish the terms of the relation between quality and quantity.

IV.

But reflection is not contented with this still confused point of view. In ancient times science found these explanations sufficient; in all things it searched only for the essence, which it identified with a certain quality. Aristotle, for instance, isolated qualities, classified them and thus settled the whole of creation in functions of one qualitative hierarchy. In the Middle Ages too, men were contented with such considerations; scholars spoke only of substantial forms, natural finalities and hæcceity.[2]

Even the Renaissance, which with its double current of scholars and mathematicians prepared the way for modern philosophy, clung to the determination of qualities belonging to things, of the forms in which they express themselves, and of the forces which they symbolize. There is nothing in that to surprise us. It is difficult for us, even now, not to interpret our internal states as real qualities of things. Why then should we wonder at the grosser illusions on which was wrecked a science which had never engaged in the study of psychical existence. Descartes's *cogito* was the signal of a reaction. While to the popular mind the growing number of experimental discoveries seemed to render more and more legitimate its belief in an external reality, to the philosopher they proved that this reality depends on ourselves since it is really known to us only when we have reduced it to a simple idea, especially that of magnitude or quantity.

The human mind knows only number adequately. By reducing perceptible things to the quantitative relations pursued by science, the horizon of thought has widened. Until then, an abyss divided self from non-self. The mind, having a conception of itself only as a mirror on which external objects are reflected, and accepting sensations as real qualities apart from itself, established on a classification of these qualities the dualism of reality, self and non-self. Since Descartes the external world is closely bound to ourselves. The illusion about quality is denounced; it is no longer of importance, but quantity (that is, numerical relation) takes its place.

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[2] From the Latin term, *haecceitas,* meaning "thisness."

With the author of *Principles of Philosophy,* mathematics is declared to be the symbol of all intelligibility and to reduce the knowledge of bodies to the laws of quantity is to bring them back to reason. The mind only grasps fully and clearly that which is reducible to the terms of ratio. Such is the nature of our thought that it can see distinctly at a glance only what it creates, so that the external world is known to it only in so much as it is the reflection of its own laws, and above all the work of the initial category of quantity from which the principles of mathematics are derived. And if since the mind has not become conscious of its conditions of existence, or in other words, since it has not understood that it can only think through analytic ideas, quality in itself is not susceptible to perfect apprehension, it is therefore reducible to something simpler than itself, and is a confused notion requiring analysis.

V.

We have seen how it is possible to understand the distinction between quality and quantity, and how the mind can pass from one to the other. It remains to show how the total reduction from the first to the second is brought about. It is the last stage in the ascent of the mind towards purely rational knowledge. This last investigation will throw a new light upon the two preceding stages of the processes we are trying to follow.

We shall see that just as in mathematics the progress of reflections consists in exhausting as far as possible the objective, concrete matter of ideas, "unceasingly diminishing the part of intuition, and seeing as little as possible in order to demonstrate better,"[8] so here the progress of knowledge will be proportional to the abandoning of the perceptible element, to the predominance of representation over affection, in short, to the substitution of mathematical formulas for the purely intensive fact.

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[8] Milhaud, *Essai sur les conditions et les limites de la certitude logique,* p. 47.

Herein lies precisely the object of physics taken in its broadest sense: to reduce the most diverse phenomena to motion, all science to mechanics. It is only a question of establishing a unit of measure for the elements of which the latter disposes, space, time, speed, form and mass of bodies in order that mathematics may adapt itself to it and furnish us with an explanation of facts. "I find," says Descartes, "that in the ideas about corporeal things one meets with very little that he can conceive clearly and distinctly, and that is to know size, or rather extension in length, breadth, and thickness, the figure that results from limiting that extension, the position that bodies of different forms hold in relation to each other, and motion or the change of that relation....As to other things such as light, color, odor, taste, heat and cold, and other qualities which come under the sense of touch, they meet in my thought with so much obscurity and confusion that I do not know whether they are real or false."[4]

The ideal of physics has not changed since that time. The question for it is still only to submit to analysis our ideas about qualities and to show that if in ourselves they are sensations, outside of ourselves they are nothing but different modifications of motion that may take place within particles of matter. Thus we must conceive the material universe as a "machine in which there is nothing at all to consider except the figures and movements of its parts,"[5] and physics in its highest abstraction is only a web of algebraic formulas, expressing forms and motions.

Then if, like M. Evellin,[6] we consider the world as a system of forces (according to the views of L'Abbé Moigno) or if like so many scholars, we study it only from a mechanical point of view, gravity, weight, mass, density, resistance, impenetrability, and many other material properties which we transform into entities will be brought back either to the mutual attraction of dynamic monads, or to a collection of partial attractions, or to combinations of movements; but whatever the explanation may be, in the last analysis it will resolve itself into a system of equations. The mechanical nature of physical phenomena, that is the reduction of quality to quantity; this is indeed the last word of science.

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[4] 3rd *Med.* I, 277; *Principes* IV, 203; III, 518.

[5] *Principes,* IV, 188.

[6] *Infini et quantité,* pp. 60-65.

It would be useless to insist any further on this point; let us rather investigate the meaning of our knowledge of things, after we have submitted them to the category of quantity.

VI.

What is a numerical relation if not a product of our thought? and why is it a product of our thought if not because laws of our thoughts are such as they are? Affirming the agreement of an external reality with a certain equation, is establishing a postulate of which nothing can warrant the foundation unless we connect it with a metaphysical idea, that of the perfect God admitted by Descartes, for instance. There may be a connection between our thought and reality; but probable as it may seem to us it is still but uncertain since in fact we only perceive through our senses, such as they are, although they might be different and since we reason by the means of what we call laws of thought such as they are but they also might be different. This starting-point admitted, the relativity of all knowledge will follow. We reduce our impressions to particular mathematical formulas, and simply by means of this reduction of a confused state to a clear idea, let us say, we manage adequately to grasp the real.

Adequately indeed, but in relation to our way of knowing. So that when we think that we are reducing external reality to a mathematical formula, it is nothing but ourselves that we are so reducing —ourselves rendering objective the product of our thought; ourselves inasmuch as the organic laws of our thought symbolize themselves, express themselves in a form we call equation for instance, and which is only a result of the laws of these thoughts beginning to act on the occasion of any kind of a sensation the cause of which is outside of ourselves.

And what may that other thing be? Subjectively (and we are coming back to our first point of view) a sensation; objectively, the same sensation entirely transformed through thought, and this is due to the fact that the category of quantity comes into play. Objectively and scientifically, the external object is only our sensation measured in what we suppose to be its cause; it is the intensive expressed by the extensive. This expression is found moreover in the question of time and space. Space is the extended, time the unextended. We can grasp fully only the former and that helps us to know the latter; and still we get to the knowledge of space only through time, which to be measured needs a conception of space.

One of these two terms is certainly primary and doubtless it is time, since it is in time that we live, while undergoing a state of consciousness of any kind; but we are forced to admit that we get an exact conception of time only when the notion of space is given us, and also the result of the application of the category of quantity to particular sensations.

The outcome of all this is that quality is scientifically the expression of a relation between two terms of which our own self is one; objectively, an illusion derived from the habits of our mind but founded on reason, inasmuch as it is an expression of the relation established between objects and ourselves; and subjectively, a sensation whose certainty lies in our own psychical existence.

VII.

We see therefore how unreasonable it is to turn quality into a category of thought, since it is reducible to that of quantity which is in reality founded on a necessity of the human mind. Now herein consists the principal characteristic of the theory of categories.[7] They are not things-in-themselves distinct in some way from thought, after the manner of the faculties admitted by the Eclectic school. To admit them as real qualities, would be going back to the system of explanation by occult powers. They are laws and still this term seems only accurate in part, for we know to how many interpretations it is liable. Whichever term we use to designate the fact that thought has states of existence, it will be impossible to determine what after all cannot be determined. Indeed we do not seize categories in the act. We infer them from all this activity of which we have only been quite conscious from the time when the results of science began to reveal themselves so considerably. Is not that the salient point of Kant's philosophy, to place science on a solid foundation? Having an immediate knowledge only of the succession of our states of consciousness, we cannot imagine in what way that wonderful structure science and society to which we all agree to grant, at least, moral certainty, has been able to build itself on the fragile basis of our ephemeral sensations. Kant attributes this to the categories of thought. This world is only my own representation, but a well-founded representation in the sense that the reality of the harmony of the external world, with the knowledge that we have of it, is all in the cognizant subject, that is in the forms of thought. Hence we see that only through induction we can become conscious of the categories; that is why we must be careful not to interpret them as realities, distinct from the sensations to which they apply, and to limit them to the simple affirmation that our thought (as well as every other thing) has its conditions of activity, which we designate by the word category.

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[7] Couturat, *L'Infini mathématique,* p. 208.

To explain mathematically, that is, to reduce to extensive magnitude what we call the qualities of bodies, remains therefore the essential condition of sure knowledge. But if we may indeed pretend that we comprehend objects only in so far as we reduce them to the clear and distinct notion of quantity, it is not less exact to maintain that something will always remain out of the reach of exact science, we mean quality, considered as one of our inner states. Those qualities which we think belong to objects, are in ourselves; they are relations. Now being such, it is difficult for us to pretend that we can reduce them to a formula absolutely exact, for of the two terms of each relation the most important, the psychological inner self, escapes any fixed determination. The proof of it is that those qualities which we know only from the intensity of one of our passing states experience variations according to the temperament of each individual. Quality subjectively taken always oscillates in the obscure vagueness of a more or less vivid state of consciousness.

The difficulty presented by the absorption of the intensive by number entitles us to wonder if there is no danger in wishing to submit by force the originality of our psychical life to the rigor of an equation. The same process of reduction of the external world to numerical relations raises the same objection. Do we not mutilate things by setting them in algebraic formulas?

We shall be content with saying that science does not in any way pretend to reduce the reality of things to a formula; but it simply affirms that the mathematical expressions in which it sets reality are to us the only condition of any perfect intelligibility. Thought has no knowledge besides the working of its laws. Now these laws are the principles of mathematics. When the mind subsumes its internal conditions to them it grasps in the operation all that is thinkable in the external object. That is what M. Couturat brought out clearly when he wrote:[8]

> "While all perceptible qualities that we draw through abstraction from the objects of experience lose all distinctness when generalized....and give place only to vague and confused concepts, the dimensions of concrete objects thus brought out through abstraction of their perceptible qualities, keep their primitive determination. That is why natural science becomes exact only when it treats of physical dimensions and when it turns perceptible qualities into measurable and calculable qualities. Scientific knowledge could not be founded on concepts because qualities are essentially heterogeneous and hence impossible to compare with one another. To take away their original intensity and their own fine distinctions to bring them under one and the same concept, heaviness or lightness, heat or cold, is indeed destroying them, and substituting for the concrete object an undecided and colorless image, without objective or scientific worth. On the other hand science took possession of nature when it resolved to determine dimensions and their relation towards each other, because dimensions being essentially homogeneous may be compared, combined, and measured, and without losing their individual precision they may be classified under a single and universal type of magnitude. After

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[8] Couturat, *L'Infini mathématique*, p. 558.

all, the concept is fatally and irremediably inadequate to the real object. Magnitude, on the contrary, is certainly not the whole object, but it is all that may be scientifically known about an object."

VIII.

Thus the problem of quality and quantity concerns at the same time: psychology, by the fact that it is in ourselves with reference to our states of consciousness that the question about the value of the two concepts arises; the criticism of the mind, inasmuch as it is important to establish the rational foundation of the transition from the intensive to the extensive by applying the notions acquired by experience to the initial category of thought; the logic of sciences, since we are compelled to found on reason the exact meaning of a term which plays so important a part in general mathematics; metaphysics, for it is impossible to do without investigating whether the two concepts have any relation whatever with fundamental existence; finally the history of philosophy, which traces for us the different points of view from which the problem of quality and magnitude has been successively faced.

To sum it up, quality and quantity are not radically opposed, except in the dominion of science; for common sense the contradiction does not exist at all. It appears only when the mind, trying to unravel the general conditions of every existence, makes the distinction between what is in itself only a *tertium quid,* resulting from the relation of things to our own selves, and what we justly call existence, which means subject to measurement or in other words that which can be subsumed under the necessary forms of thought.

Quality, scientifically speaking, is a point of view relating to the exigencies of our body in its relation to external objects; it is in us the more or less confused feeling of something good or evil for our organism. Quantity is the irreducible point of view of thought in its effort to reflect and classify the world.

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